



Cherry Creek Dam PMP Fact Sheet

1. What is the PMP?

The probable maximum precipitation (PMP) is theoretically the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular geographic location at a certain time of the year.

- ◆ It is the greatest amount of rainfall possible over a drainage basin for a storm event.

2. How is the PMP Estimated?

The procedures used in the development of the PMP by the Scientist are very complex and based on standardized guidance and their meteorological experience and understanding. The procedure includes transposing historical storm data from one nearby location to another and maximizing atmospheric conditions (i.e. maximum moisture in the air) so that they cause the maximum rainfall to occur for extreme meteorological conditions. In addition, due to the front range and its topography, orographic effects have to be accounted for. PMP studies can be categorized into two types:

- a) Generalized Regional Study – Generalized precipitation values and standardized procedures applied to large areas on a regional or national scale. Based on historical storm and meteorological data. Examples: National Weather Service (NWS) publications HMR52, HMR55A, etc.
- b) Site Specific – Based on historical storm and meteorological data. Accounts for specific topographic features of the basin that may be overlooked in a generalized regional study. The 1995 site-specific PMP study for the Cherry Creek basin was used for the current dam safety/EIS study.

3. Who Develops the PMP?

Because of NWS's expertise in developing PMP's, the Corps of Engineers and NWS have a cooperative agreement where the NWS develops the PMP's used in the spillway design flood on Corps projects. They are also the lead agency in the development of generalized regional PMP studies such as HMR 52 and HMR 55A in cooperation with the Corps and the Bureau of Reclamation.



4. Why is the PMP used?

A PMP is used because it allows dams to be designed for events that can possibly occur in the area. The previous method for designing dam spillways only referred to rainfall events that had actually occurred in the study area.

A PMP is utilized in the design of a dam to meet dam safety requirements and is NOT used for the design of the flood control portion of a dam. In the design of dams and reservoirs, two major design flood events are generally used. These hypothetical flood events are referred to as the Reservoir Design Flood and the Spillway Design Flood. The Reservoir Design Flood (RDF) is the flood that establishes storage volumes required to provide the level of flood control desired by a reservoir project. The spillway crest is normally set at the maximum pool level that would occur during the RDF.

The Spillway Design Flood (SDF) is the hypothetical flood event that the dam is designed to safely pass with adequate freeboard, considering antecedent conditions, water control plans, and regulating outlet capabilities. For a new dam, the SDF is generally used to determine the required spillway capacity and top of dam elevation, considering surcharge storage and freeboard requirements. It is the Corps of Engineers (COE) policy that dams designed, constructed, or operated by the COE will not create a threat of loss of life or inordinate property damage. When a dam impounds water upstream from a populated area, a distinct hazard to that area from possible failure of the dam is created. Four different standards are used by the COE in determining the spillway design flood. Standard 1 applies to the design of dams capable of placing human life at risk or causing a catastrophe, should they fail. Cherry Creek Dam falls into this category. For Standard 1 dams, the SDF is based on the Probable Maximum Precipitation (PMP) occurring over the watershed above the dam site. This standard is applied to all dams designed today by the Corps of Engineers and was used on the nearby Chatfield dam, Westerly Creek dam, and Bear Creek dam spillway designs.

Although Cherry Creek dam still provides the flood control protection that it was designed for, the dam embankment could fail by an event equal to 75 percent of the SDF. The Cherry Creek dam safety study currently in progress is being conducted to resolve the deficiency.

5. How was the PMP for Cherry Creek Developed?

The Cherry Creek project was designed in 1944. At that time, spillway design floods were normally based on the historic storm of record in the region or to use the storm of record multiplied by a factor of safety. The Cherry Creek spillway design flood was based on the May 30-31, 1935 storm centered over the South Republican River basin and was multiplied by a “reliability factor” of 25 percent.

Subsequent to the construction of Cherry Creek dam, this method of using a historic event was found to be inadequate in development of spillway design floods and

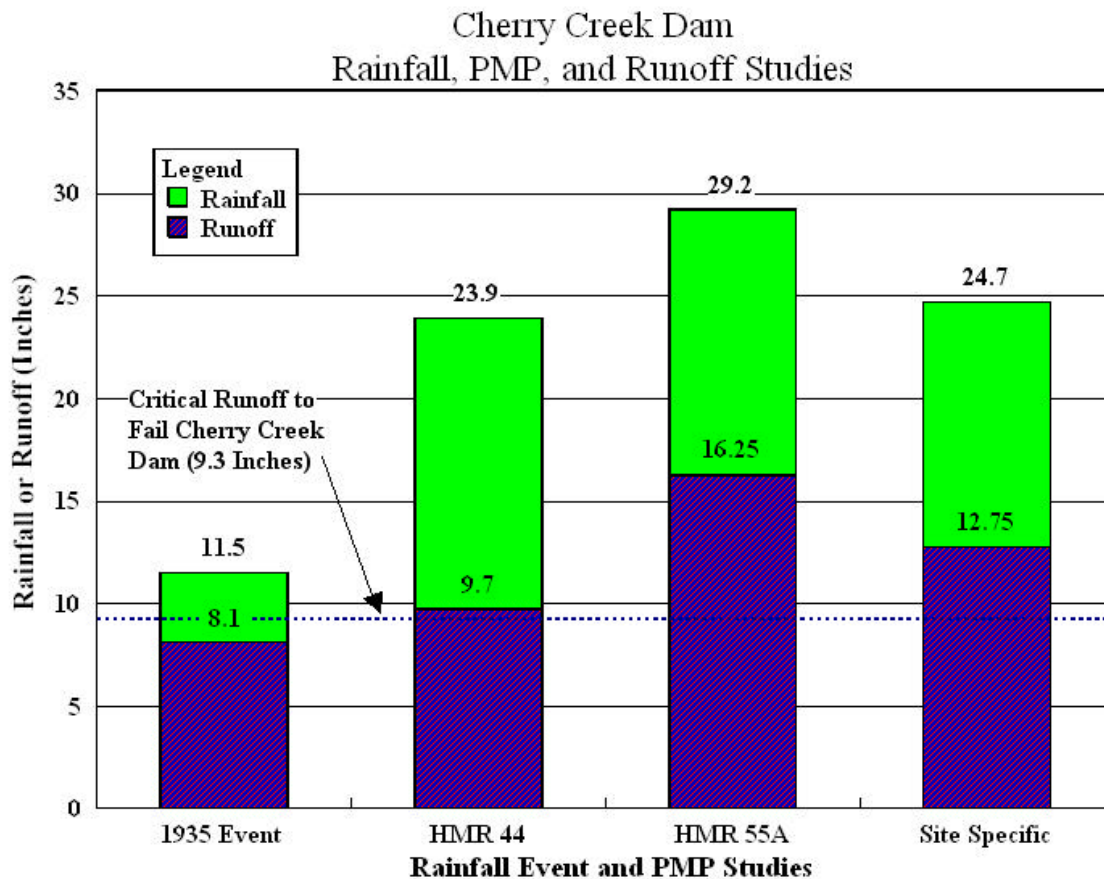


was replaced with the PMP analysis as more storm data was documented and a better understanding of how extreme rainfall events occur. The original rainfall event and PMP studies derived for Cherry Creek dam for the spillway design flood and subsequent dam safety analyses are listed below followed by Table 1 which lists pertinent data for each event. The total rainfall and runoff are shown in Figure 1. In addition, the critical amount of runoff needed to fail Cherry Creek dam is also displayed.

- ◆ 1935 Event – May 30-31, 1935 event over the South Republican River basin transposed over Cherry Creek.
- ◆ HMR 44 – 1970 Site Specific PMP for Chatfield Dam applied to Cherry Creek basin. Developed by the NWS.
- ◆ HMR 55A – NWS Generalized Regional Report published in 1988 for the area between the Continental Divide and the 103rd Meridian.
- ◆ Site Specific – 1995 analysis specifically for Cherry Creek basin. Developed by the NWS.

Table 1
Cherry Creek PMP and Storm Study History

PMP and Storm Studies	Storm Length (Hours)	Total Rainfall (Inches)	Runoff (Inches)	Peak Discharge (cfs)	Volume (ac-ft)
1935 Event Pattern	9	11.5	8.1	180,700	166,700
HMR 44	96	23.90	9.70	376,000	207,000
HMR 55A	96	29.22	16.25	635,000	359,200
Site Specific PMP	72	24.70	12.75	524,700	262,500



Note: A critical runoff of 9.3 inches over the entire 386 square mile Cherry Creek drainage basin would be of sufficient volume to fill Cherry Creek dam and fail it based on Corps Dam Safety criteria.

Figure 1

6. How are PMP's Verified?

PMP's are the greatest amount of rainfall possible in a basin and by definition should not be exceeded. Therefore, finding historical extreme rainfall events to verify the PMP is difficult to do. However, rainfall events that approach the PMP will help in proving that extreme rainfall events do occur in or around the Cherry Creek basin. Table 2 lists historic extreme rainfall events that have occurred in Colorado along with the storm length and the maximum measured rainfall depth.



Table 2
Extreme Rainfall Events in Colorado

Location (County)	Date	Duration (Hours)	Peak Rainfall Depth (Inches)
Pueblo, CO (Pueblo)	Jun 4-5, 1921	12	12
Cherry Creek (Elbert)	May 30-31, 1935	5	24
Hale, CO (Yuma)	May 30-31, 1935	9	24
South Platte River Basin	June 16-17, 1965	6	14
Big Thompson	Jul 31-Aug 1, 1976	5	12
Fort Collins, CO (Larimer)	Jul 28, 1997	6	10+
Pawnee Creek (Logan)	Jul 29-30, 1997	6	15+

In addition, PMP's developed and utilized for other nearby basins for spillway design on dams that were constructed will assist in determining if the methods and procedures used for the PMP on Cherry Creek are generally accepted and considered reasonable.

- ◆ Chatfield Dam – Site Specific PMP (HMR 44) for spillway design on Chatfield Dam. September 1966.
- ◆ Bear Creek – HMR 44. June 1970
- ◆ Westerly Creek – HMR 55A. December 1987.

The rainfall amounts shown in Table 2 are for a single location where a rainfall measurement was taken in a basin. The average rainfall amount over a large area would be less than that of a single maximum rainfall value. Therefore, another way to verify the data used in a PMP study is to compare what the average rainfall amount is over a larger area for a certain length of time such as 6 hours or 12 hours. For Cherry Creek, the PMP was based on a 72-hour rainfall event. However, the actual runoff (when rainfall exceeds infiltration into the soil) from that event only occurs during a 9 hour period as shown in Figure 2. Table 3 lists the rainfall amounts for historic events and other PMP events as compared to the site specific PMP for the 386 square mile Cherry Creek drainage basin.

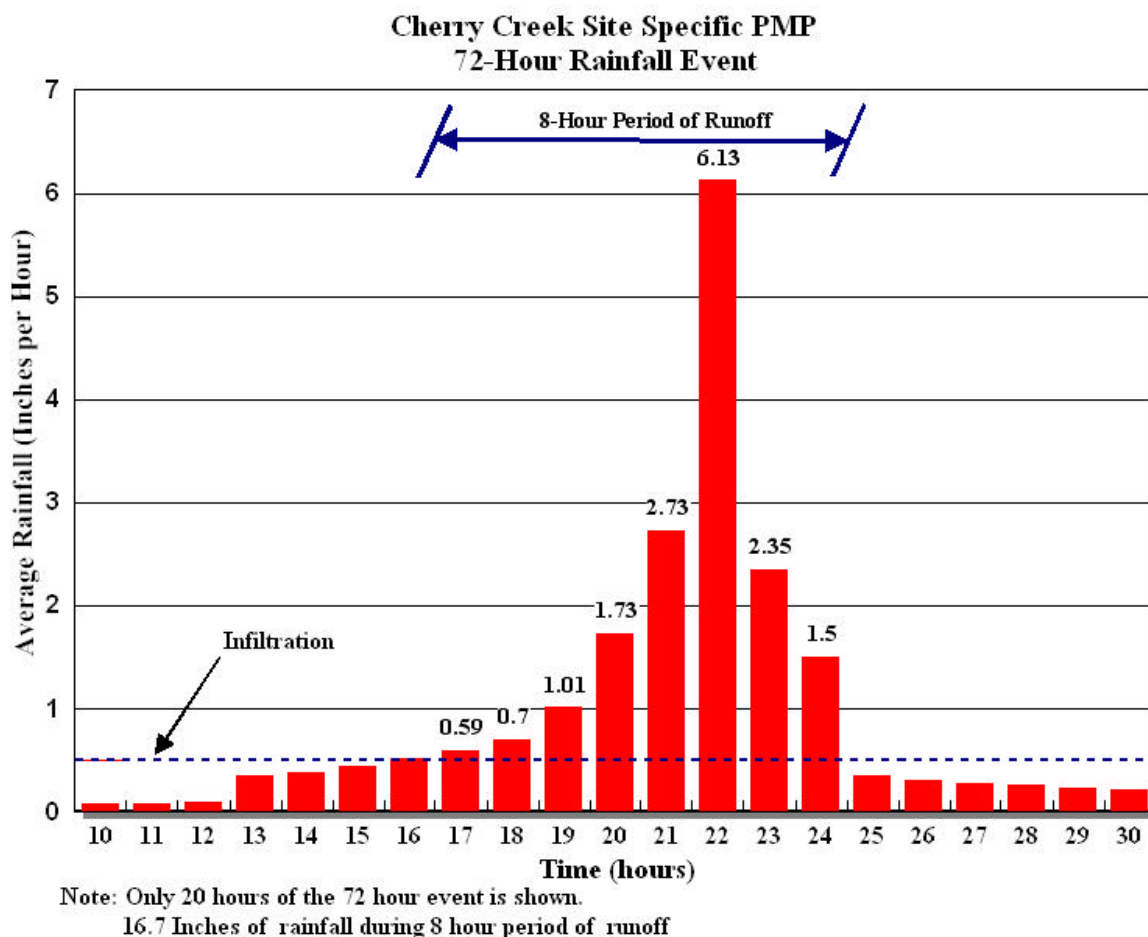


Figure 2

Table 3
Average Rainfall Amounts for a 6-Hour and 12-Hour Storm Period
For a 386 Square Mile Basin (Cherry Creek Basin)
Historic Rainfall Events and PMP's

Location (County)	Date or Type of Storm	Rainfall (Inches)	
		6-Hour	12-Hour
Pueblo, Co (Pueblo)	Jun 4-5, 1921	7.0	10.3
Cherry Creek (Elbert)	May 30-31, 1935	9.9 (5 Hour)	-----
Hale, Co (Yuma)	May 30-31, 1935	8.4	9.2
Falcon, Co (El Paso)	June 16-17, 1965	10.0	-----
Larkspur, Co (Douglas)	June 16-17, 1965	6.8	-----
Pawnee Creek (Logan)	Jul 29-30, 1997	6.7	-----
HMR 44 – Cherry Creek	PMP	12.5	14.3
HMR 55A – Cherry Creek	PMP	17.8	22.1
Site Specific – Cherry Creek	PMP	15.5	18.4